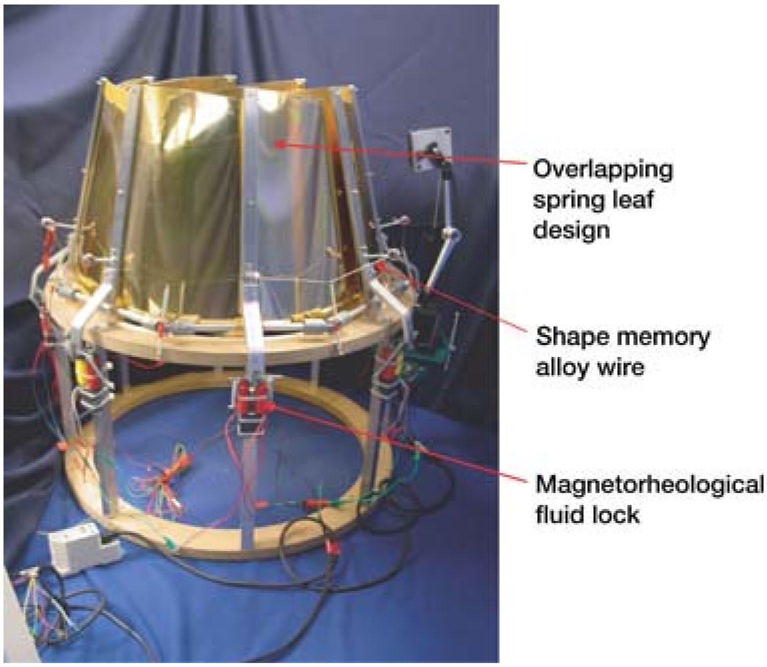
Prototype Morphing Fan Nozzle Demonstrated



Prototype of a variable-area fan nozzle implementing overlapping spring leaf assembly, shape memory alloy wire actuators, and magnetorheological fluid locks.

Ongoing research in NASA Glenn Research Center's Structural Mechanics and Dynamics Branch to develop smart materials technologies for aeropropulsion structural components has resulted in the design of the prototype morphing fan nozzle shown in the photograph. This prototype exploits the potential of smart materials to significantly improve the performance of existing aircraft engines by introducing new inherent capabilities for shape control, vibration damping, noise reduction, health monitoring, and flow manipulation. The novel design employs two different smart materials, a shape-memory alloy and magnetorheological fluids, to reduce the nozzle area by up to 30 percent.

The prototype of the variable-area fan nozzle implements an overlapping spring leaf assembly to simplify the initial design and to provide ease of structural control. A single bundle of shape memory alloy wire actuators is used to reduce the nozzle geometry. The nozzle is subsequently held in the reduced-area configuration by using magnetorheological fluid brakes. This prototype uses the inherent advantages of shape memory alloys in providing large induced strains and of magnetorheological fluids in generating large resistive forces. In addition, the spring leaf design also functions as a return spring, once the magnetorheological fluid brakes are released, to help force the shape memory alloy wires to return to their original position. A computerized real-time control system uses the derivative-gain and proportional-gain algorithms to operate the system.

This design represents a novel approach to the active control of high-bypass-ratio turbofan engines. Researchers have estimated that such engines will reduce thrust specific fuel consumption by 9 percent over that of fixed-geometry fan nozzles. This research was conducted under a cooperative agreement (NCC3-839) at the University of Akron.

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